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Review of new facilities on a TL/OSL reader for retrospective dosimetry

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This presentation summarises recent major improvements and new attachments to the Risø TL/OSL reader. These have mainly been in response to the ever growing need (i) for higher precision and accuracy in dose measurements, (ii) to improve our understanding of the physics of the luminescence processes, and (iii) to extend the dose range.

A pulsed stimulation (POSL) and time resolved (TR) single photon counting facility has been developed [1] to aid investigations in luminescence physics, and for the separation of luminescence signals of interest from mixed signals with very different luminescence lifetimes. The TR-POSL facility, with its high temporal resolution in data acquisition (< 1 ns), together with the ability to use different stimulation wavelengths (from blue, green and IR LEDs) and temperatures, provides a powerful tool for investigating the complexity of charge movement during OSL; this, for example, has been recently applied to feldspar luminescence [2]. The standard POSL offers PMT gating in selectable stimulation off-periods thereby providing a routine approach to maximising the signal-to-noise ratio (by suppressing the breakthrough), and to isolating the signal of choice from mixed samples. An dedicated program for analysis of TR-POSL data can present the data as 3D surface plots and post-process the data to provide standard OSL decay curves derived from up to 5 individually defined gating intervals.

There is considerable demand for extending the age range of luminescence dating. An improved violet stimulation attachment has been developed to access deep traps in quartz [3] with extended dose response. This attachment includes a 405 nm laser diode delivering ~ 70 mW/cm² to the sample position, and appropriate filtration of both the stimulation and the detection light. Typical breakthrough is ~ 500 cps with the sample held at 125°C. To access the extended dose response of feldspars, an IR radio-fluorescence facility has been developed; others have argued that this method samples a stable, non-fading signal from K-feldspars [4]. A cooled red sensitive photomultiplier module (Hamamatsu H7421-50) is coupled through a light guide to the sample position under the beta irradiator. Analysis software has been developed for routine, automated dose measurements using a single-aliquot procedure [5].

A significant fraction of the dose absorbed by natural K-rich feldspar samples originates from internal ⁴⁰K. In the absence of routine concentration measurements, most dating studies assume an internal K content of 12%, based on stoichiometry. To test this assumption, and for routine use in luminescence dating, we have developed an X-ray fluorescence spectrometer attachment and an analytical method for major element analysis of quartz and feldspar separates; this results in a relative estimate of Na-, K-, Ca-feldspar and quartz from each sample disc.

Several improvements have also been made to increase precision and accuracy of dose measurement during routine measurements. For example a simple method for characterising, quantifying and correcting any irradiation field non-uniformity has been developed; this is especially important for reducing over-dispersion in single-grain dose estimates. Similarly, it is often deemed necessary to know the grain count and grain size distribution for each sample disc. A sample camera with built-in illumination is now available; this gives 5 Mpixel sample images for routine image processing and documentation. Finally a correction method has been developed for bright samples that give count rates in the non-linear region of the PMT. Using this method the maximum usable count rate is increased from ~ 5 to ~ 40 Mcps.

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